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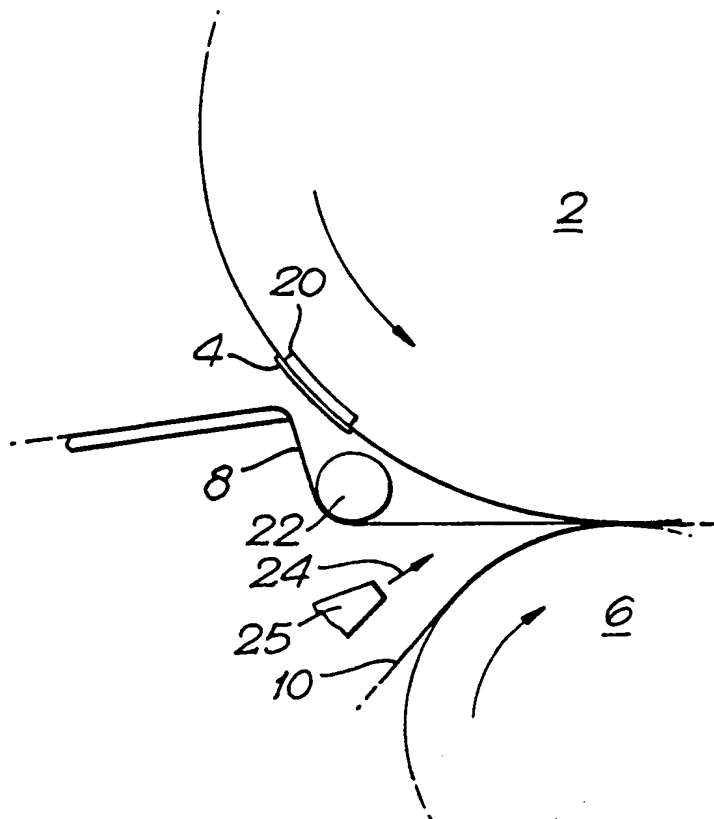
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| (21) International Application Number: PCT/GB96/01227 (22) International Filing Date: 22 May 1996 (22.05.96) (30) Priority Data: 9510430.3 22 May 1995 (22.05.95) GB (71) Applicant (for all designated States except US): MOLINS PLC [GB/GB]; 11 Tanners Drive, Blakelands, Milton Keynes, Bucks MK14 5LU (GB). (72) Inventors; and (75) Inventors/Applicants (for US only): AINDOW, Alan, Michael [GB/US]; 1699 Alu Street, Hilo, HI 96720 (US). CAHILL, Michael, John [GB/GB]; (GB). SANTON, David [GB/GB]; University of Warwick Science Park, 2 Sir William Lyons Road, Coventry CV4 7EZ (GB). (74) Agent: WEBB, John, Charles; Molins plc, Haw Lane, Saun- derton, High Wycombe, Bucks HP14 4JE (GB). | | (81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i> |

(54) Title: PRINTING METHOD AND APPARATUS**(57) Abstract**

In security printing apparatus for attaching a foil imprint of predetermined shape to stock (10) such as bank note sheets, a tape (8; 108) carrying foil to be printed and a layer of hot-melt adhesive is conveyed with the stock past a heated printing roll (2; 102). In order to allow high printing speeds the adhesive is at least partially activated by pre-heating just prior to printing. The pre-heating means may comprise hot air, radiation or heated guide means for the foil carrier web. Details of pattern or shape may be etched on the foil, either before or after printing, by means of laser beam, the details being defined by a mask moving with the foil.



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Printing Method and Apparatus

This invention relates to printing apparatus, and in particular to such apparatus for carrying out a process commonly known as hot foil stamping.

In security printing apparatus it is known to apply a thin layer of metal foil of predetermined shape and/or pattern to a stock, e.g. a sheet of bank notes, usually as a feature intended to make counterfeiting more difficult. In a typical application the foil is carried as a continuous lamination between a carrier substrate and a layer of hot melt adhesive, the shape or pattern to be applied being determined by a stamp or press. In prior art arrangements the carrier substrate and the stock (e.g. a sheet of bank notes) are placed together beneath a platen-type press carrying an array of stamps which are simultaneously applied to cause an array of hot foil imprints to be applied to the stock. Heat for activating the hot melt adhesive is generally applied from the press, and an inability to transfer heat sufficiently quickly is a factor in limiting the speed of such prior art arrangements.

According to a first aspect of the invention printing apparatus for applying foil to a stock comprises means for conveying a carrier for the foil together with an adhesive which is activated by heat towards a printing position, means for conveying a stock towards said printing position, printing means at which the carrier and stock are moved together past said printing position at which pressure is applied to transfer a predetermined pattern and/or shape of foil from the carrier to the stock, and pre-heating means for transferring heat to the carrier before it reaches the printing position and/or before it contacts the stock. Preferably the pre-heating means is effective to transfer heat to the carrier immediately upstream of the printing position. For example, where the printing means comprises a nip between a print wheel and a counter wheel the pre-heating means may be located to be effective as close as possible to said nip. Preferably the pre-heating means comprises means directed particularly at the adhesive layer, e.g. comprising radiation or hot air directed at said layer.

In a preferred arrangement the printing means comprises means for applying both pressure and heat at said printing position. For example, the printing means may comprise a print wheel carrying one or more stamps defining said predetermined pattern and/or shape, the

1 wheel carrying heating means in the vicinity of said stamp or stamps.

2 The printing apparatus may form part of security printing
3 apparatus of the type disclosed in EP 0441596A, the disclosure of which
4 is hereby incorporated herein in its entirety. This apparatus discloses a
5 security printing process in which thin film security material is
6 transported on a carrier ribbon past a printing position together with a
7 moving stock.

8 According to another aspect of the invention a method of applying
9 foil to a substrate by means of pressure and heat to secure the foil to the
10 substrate by means of a hot melt adhesive in which the foil and substrate
11 are moved together past a printing position so that successive foil
12 imprints are made at said position, includes a process step in which the
13 adhesive carried with the foil is pre-heated before it reaches said
14 position.

15 According to a further aspect of the invention a method of
16 applying foil to a substrate by means of pressure and heat to secure the
17 foil to the substrate by means of a hot melt adhesive in which the foil and
18 substrate are moved together past a printing position so that successive
19 foil imprints are made at said position includes the step of laser etching
20 the shape or pattern of the foil either upstream or downstream of the
21 printing position. Preferably said laser etching is carried out using a
22 suitably shaped or patterned mask which is moved together with the foil.

23 The invention will be further described, by way of example only,
24 with reference to the accompanying diagrammatic drawings, in which:

25 Figure 1 is a side view of part of a foil printing apparatus,

26 Figure 2 is a sectional view, not to scale, of a carrier tape
27 including a layer of foil to be printed,

28 Figure 3 is a cross-sectional view, not to scale, of a printing stamp
29 usable with the apparatus of Figure 1,

30 Figure 4 is a side view of a security printing machine incorporating
31 foil printing apparatus, and

32 Figure 5 is a perspective view of the foil printing apparatus in the
33 machine of Figure 4.

34 Figure 1 shows a driven printing wheel 2 carrying one or more
35 heated dies or stamps 4 which cooperate with a substrate wheel 6. The
36 wheel 6 has a sleeve comprising a flexible polymer printers' makeready.
37 A tape 8 carrying foil to be printed is delivered to the nip of the wheels 2
38 and 6 along with a web or sheet 10 on which a foil pattern corresponding

1 to that on the stamp 4 is to be printed.

2 The apparatus shown in Figure 1 forms part of a security printing
3 machine such as that disclosed in EP 0441596A. In particular, the
4 wheels 2 and 6 correspond to the cylinders 46 and 48 in that machine.
5 The tape 8 is driven in the same manner as the tape 34 in EP 0441596A,
6 that is to say for each printing cycle it is accelerated up to the speed of
7 the web 10 (normally corresponding to the peripheral speed of the
8 wheels 2 and 6), maintained at that speed through the nip between the
9 wheels 2 and 6 while the stamp 4 passes through the nip, and
10 subsequently decelerated to rest and reversed so that the net advance
11 of the tape for each printing cycle only slightly exceeds the length of the
12 image to be imprinted by the stamp 4.

13 Figure 2 is a cross-sectional view (not to scale) showing the tape
14 8, which comprises four layers: a polyester carrier layer 12, a layer 14 of
15 release wax, a layer 16 of foil, typically aluminium, and a layer 18 of a hot
16 melt adhesive. Typical thickness (in mm) for each of the layers of the
17 tape 8 are:

| | | |
|----|--------------------|--------------|
| 18 | Carrier (12): | 0.012-0.030 |
| 19 | Release Wax (14) : | 0.0001 |
| 20 | Foil (16): | 0.001-0.002 |
| 21 | Adhesive (18) | 0.001-0.003. |

22 Figure 3 is a sectional view of a typical stamp 4, indicating that it
23 comprises areas 4A intended for printing and areas 4B which are
24 relieved, by up to 2mm as indicated at X, and hence not to be printed.
25 Within some of the areas 4A there are micro-engravings 4C, which are
26 raised by typically 0.02-0.03mm above the general level of the area (as
27 indicated at Y) and are intended to produce fine detail in the imprint.

28 In operation, the tape 8 and web 10 travel through the nip which is
29 subject to a high pressure (typically 350-1000bar) so that the stamp 4
30 causes a pattern of foil corresponding to that determined by the raised
31 area of the stamp to be released from the carrier layer 12 and to be
32 adhesively secured to the web 10 by means of the hot melt adhesive
33 layer 18 activated by the heated stamp 4. Pressure at the nip is much
34 lower during periods when a stamp 4 is not passing through, so that the
35 tape 8 may be decelerated and reversed as previously explained.

36 At higher speeds (up to 2m per second or more) and for detailed
37 patterns to be transferred by the stamp 4 it is important that sufficient
38 heat is transferred to the tape 8 to activate the hot melt adhesive layer

18. Although the stamp 4 is heated, typically to a temperature in the range 120-170°C by a cartridge heater 20 carried by the wheel 2, there may be insufficient time for adequate heat to penetrate the tape 8 to the layer 18. Increasing further the temperature of the stamp 4 may cause physical damage to the tape 8. In order to provide adequate heat at the layer 18, therefore, pre-heating of the tape 8 is effected by passing it around a heated bar (or roller) 22, which may be heated to a temperature in the range 60-120°C.

Although passing the tape 8 around the bar 22 is effective in providing additional heat just upstream of the position at which printing takes place, this heat is still applied from the side of the tape remote from the adhesive layer 18. Although it is not possible to pass the layer 18 over a heated surface as this would release adhesive on to the surface, additional or alternative pre-heating can be provided on the side of the layer 18 by directing hot air at it just upstream of the nip between wheels 2 and 6, as indicated at 24 in Figure 1 where hot air is supplied by a blower unit 25. Additionally, or as a further alternative, heat may be supplied by directing infra-red radiation at the layer 18 just upstream of the nip (i.e. the unit 25 could include or consist of an infra-red radiator). The frequency of the radiation may be selected so as to be appropriate to the material of the hot-melt adhesive, i.e. so as to be readily absorbed by it. A further possibility would be to use microwave radiation: this might also be directed from the side of the adhesive layer 18, but could be directed from the other side of the tape 8 and still cause effective activation of the hot melt adhesive.

Any of the means of pre-heating could be used in combination: in all cases the pre-heating is preferably carried out closely adjacent to the printing position, as the thermal mass of the tape 8 is small and its surface area relatively large so that it loses heat and returns to ambient temperature rapidly.

The security printing machine shown in Figure 4 comprises a sheet feeding unit 130 for feeding sheets 110 from successive stacks 132 delivered to the unit. Each successive sheet 110 is fed down a ramp 134 to a lay device 136 which transfers the sheet onto a substrate wheel 106. The wheel 106 cooperates with a print wheel 102 carrying heated stamps (not shown) which are similar to the stamps 4 so as to cause a foil imprint to be applied to the sheet 110 in predetermined positions. Printed sheets 110 are conveyed by suction around the wheel 106 and

1 transferred to a belt conveyor 138 provided with individual sheet grippers
2 140. The conveyor 138 delivers printed sheets 110 to a stacking unit
3 142 having two stacking positions.

4 A carrier tape 108, similar to the tape 8, is delivered from a reel
5 144 through a suction reservoir 146, which provides tension for the tape,
6 to the nip between the print wheel 102 and the substrate wheel 106.
7 Just upstream of this nip the tape 108 passes a pre-heating unit 148,
8 which comprises infra-red heating elements directing radiation at the
9 adhesive layer of the tape but which could comprise alternatively or
10 additionally any of the other pre-heating means described with reference
11 to Figure 1 or any other convenient pre-heating means. Downstream of
12 the wheels 102 and 106 the tape 108 passes between drive rolls 150 and
13 is subsequently collected in a waste unit 152.

14 As is apparent from Figure 5, the reel 144 carries multiple
15 laterally-spaced tapes 108 (although only one tape run is shown in
16 Figure 5) so that foil imprints can be simultaneously placed at
17 laterally-spaced predetermined positions on the sheets 110 which, as
18 indicated, may comprise several images (e.g. for bank notes) across
19 their widths. The arrangement is similar to that disclosed in
20 EP 0441596A, where each of the sheets to be printed consisted of 10
21 bank notes across the width and there were correspondingly ten ribbons
22 corresponding to the tape 108.

23 It is possible to etch details of shape or pattern on the foil by
24 means of a suitable laser beam (e.g. a CO₂ laser). The etching may take
25 place on the tape, i.e. before printing, or on the foil applied to the sheet,
26 i.e. after printing, or possibly both before and after printing. The pattern
27 or detail to be etched may be defined by means of a mask moving at the
28 same speed as the tape or sheet: in addition the beam itself may be
29 scanned relative to the tape or sheet. Laser etching may avoid the need
30 for stamps with particularly detailed shapes or patterns, these being
31 provided by the laser in combination with a basic stamp pattern. Clearly
32 the power intensity of the laser beam needs to be closely controlled so
33 as to remove only foil (or foil and adhesive in the case of etching of the
34 tape) without causing damage to the underlying material.

Claims:

1. A method of applying foil to a substrate by means of pressure and heat to secure the foil to the substrate by means of a hot melt adhesive in which the foil and substrate are moved together past a printing position so that successive foil imprints are made at said position, including a process step in which the adhesive carried with the foil is pre-heated before it reaches said position.

2. Apparatus for applying foil to a stock, comprising means (150) for conveying a carrier (8; 108) for the foil together with an adhesive which is activated by heat towards a printing position, means (6; 106) for conveying a stock towards said printing position, printing means (2; 102) at which the carrier and stock are moved together past said printing position at which pressure is applied to transfer a predetermined pattern and/or shape of foil from the carrier to the stock, and pre-heating means (22,25; 148) for transferring heat to the carrier before it reaches the printing position and/or before it contacts the stock.

3. Apparatus as claimed in claim 2, wherein the pre-heating means (22,25; 148) is arranged to transfer heat to the carrier immediately upstream of the printing position.

4. Apparatus as claimed in claim 2 or claim 3, wherein the printing position includes a nip between a printer wheel (2; 102) and a counter wheel (6; 106) and the preheating means (22,25; 148) is arranged to supply heat to the carrier and it is delivered into said nip.

5. Apparatus as claimed in any of claims 2 to 4, wherein the pre-heating means includes means (25) for directing radiation at said adhesive layer.

6. Apparatus as claimed in any of claims 2 to 5, wherein the preheating means includes means (25) for directing hot gas at said adhesive layer.

7. Apparatus as claimed in any of claims 2 to 6, wherein the printing means (2; 102) includes means (4) for applying both pressure

1 and heat at said printing position.

2
3 8. Apparatus as claimed in claim 7, wherein the printing
4 means comprises a print wheel (2; 102) carrying one or more stamps (4)
5 defining said predetermined pattern and/or shape.
6

7 9. A method of applying foil to a substrate by means of
8 pressure and heat to secure the foil to the substrate by means of a hot
9 melt adhesive in which the foil and substrate are moved together past a
10 printing position so that successive foil imprints are made at said
11 position, including the step of laser etching the shape or pattern of the
12 foil either upstream or downstream of the printing position.
13

14 10. A method as claimed in claim 9, wherein said laser etching
15 is carried out using a mask which is moved together with the foil.
16

17 11. A method as claimed in claim 1 and either claim 9 or claim
18 10.
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Fig.1.

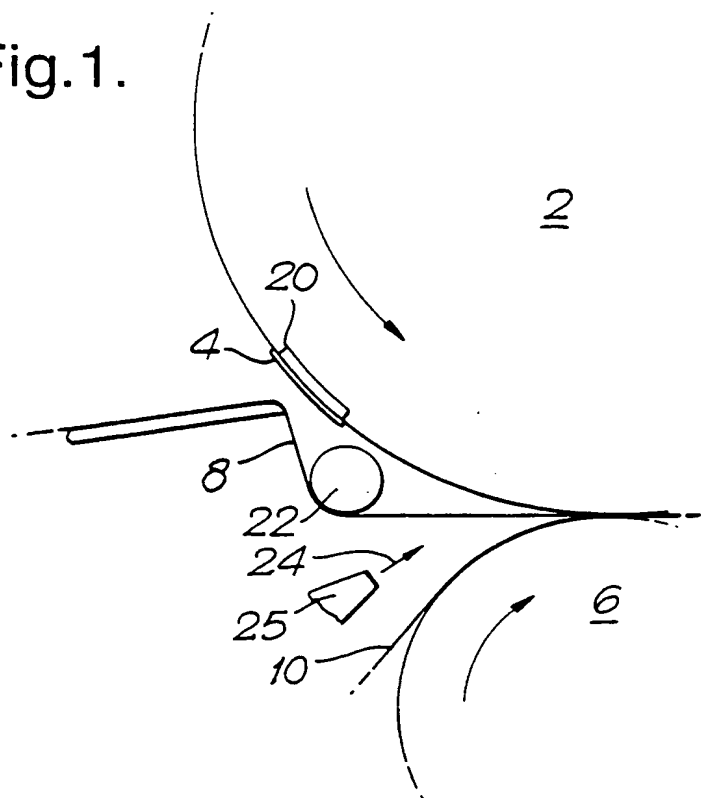


Fig.2.

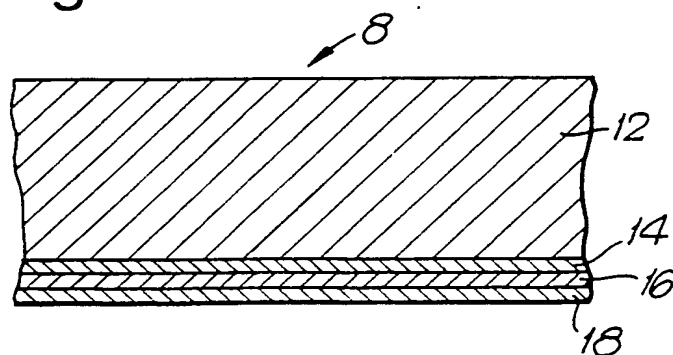


Fig.3.

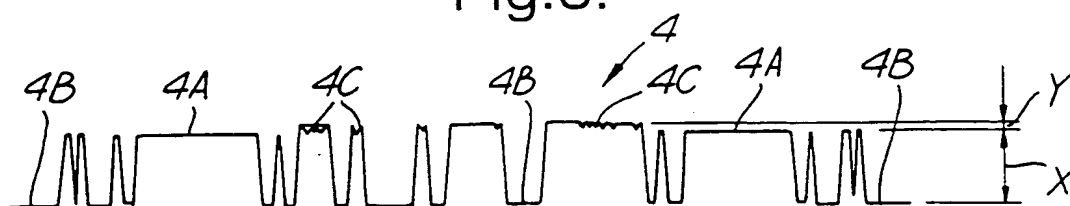


Fig.4.

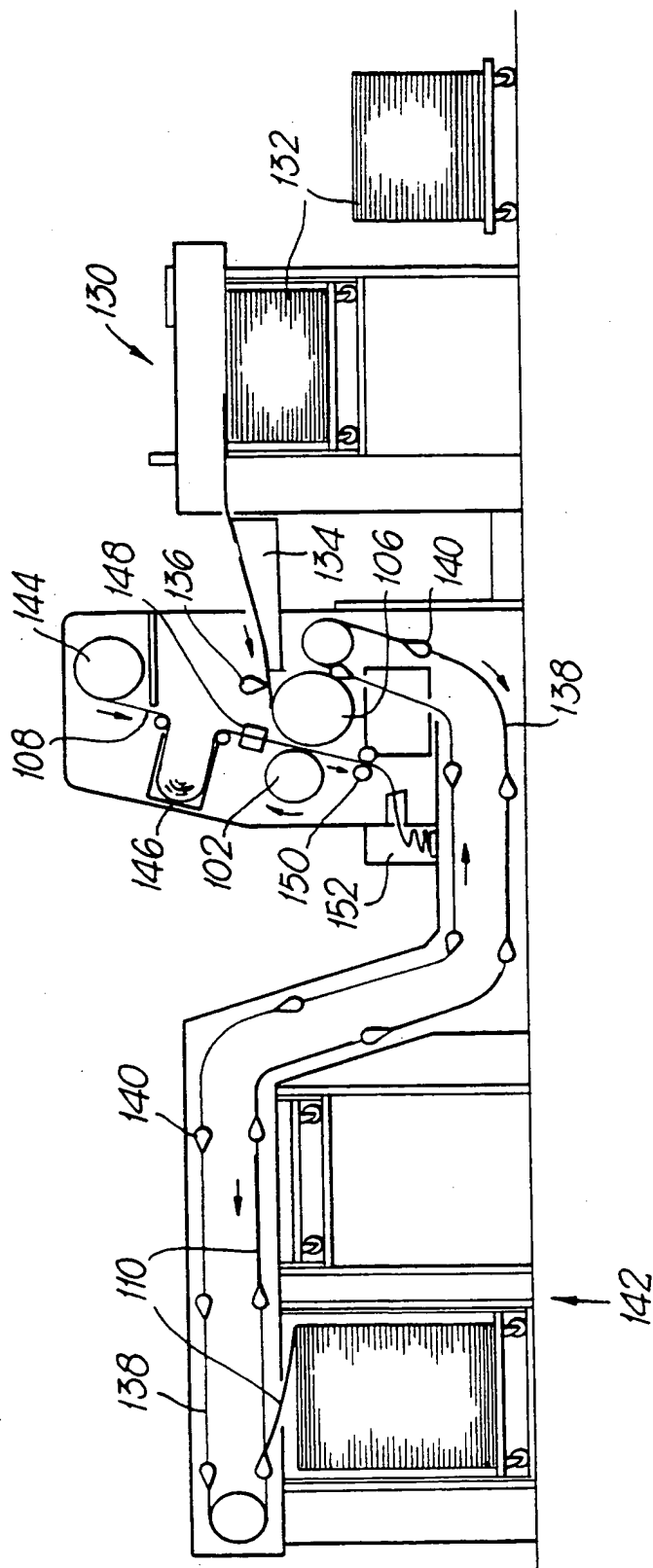
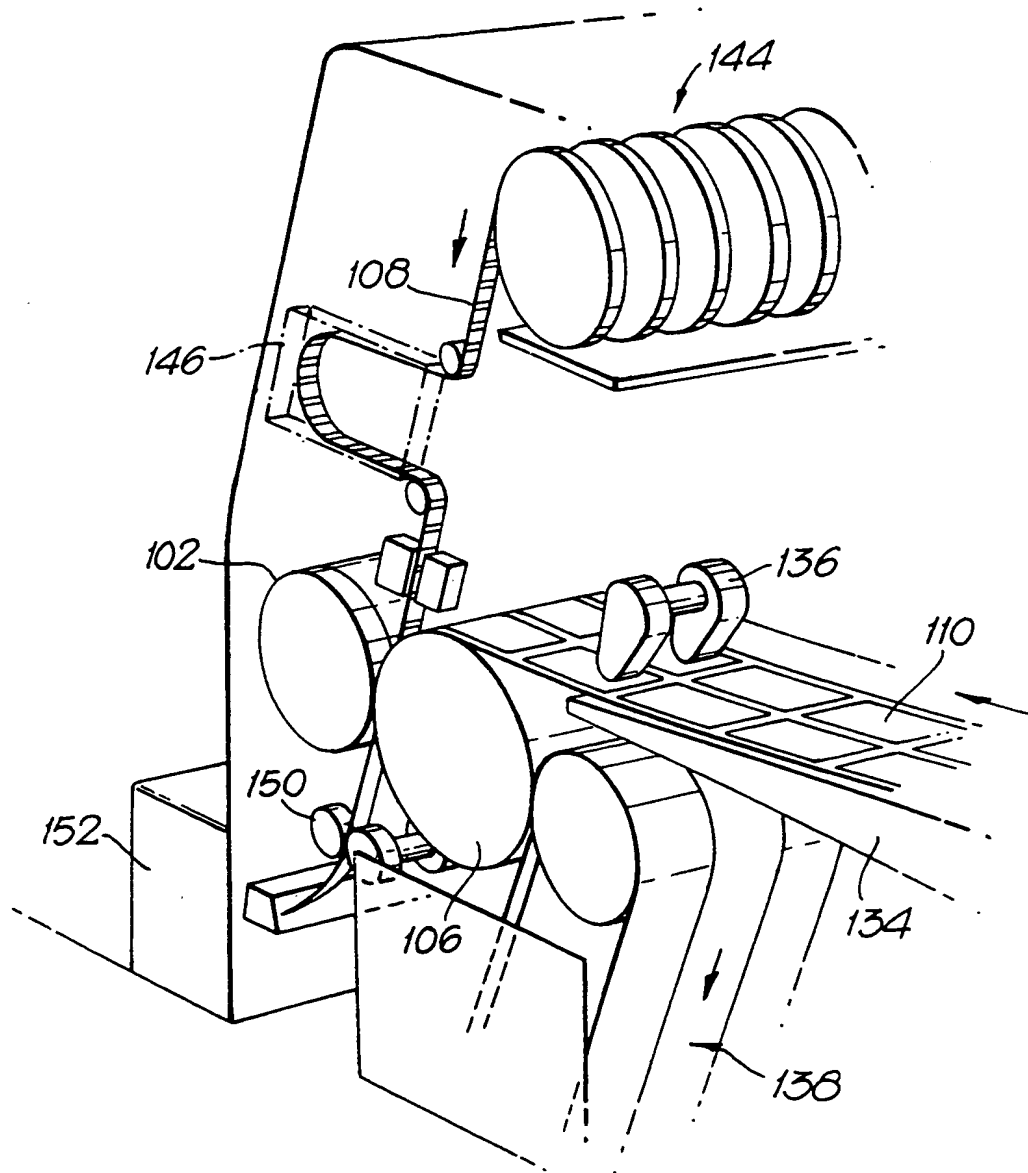


Fig.5.



INTERNATIONAL SEARCH REPORT

Inter Application No

PCT/GB 96/01227

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B41F19/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B41F B41L B44C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|---|-----------------------|
| X | US 4 340 438 A (DAVIS) 20 July 1982 see the whole document --- | 1-3 |
| X | EP 0 089 494 A (LEONARD KURZ) 28 September 1983 see the whole document --- | 1-3 |
| X | PATENT ABSTRACTS OF JAPAN vol. 18, no. 398 (M-1645), 26 July 1994 & JP 06 115048 A (TOPPAN PRINTING CO LTD.), 26 April 1994, see abstract --- | 1-4 |
| A | GB 2 255 317 A (PROFOIL SYSTEMS LTD.) 4 November 1992 --- | |
| A | EP 0 324 238 A (DELCO ELECTRONICS OVERSEAS CORP.) 19 July 1989 --- | |
| | --- -/-- | |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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|------------|--|-----------------------|
| A | GB 896 973 A (MILFORD-ASTOR LTD.) 23 May 1962 ----- | |

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB 96/ 01227

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

I. Claims 1-8,11: Method and apparatus for applying foil to a substrate by means of pressure and heat wherein the adhesive is pre-heated

II. Claims 9-10: Method for applying foil to a substrate by means of pressure and heat wherein the pattern is laser etched

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 96/01227

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| EP-A-89494 | 28-09-83 | DE-A- 3210551 | 06-10-83 |
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| | | US-A- 4802949 | 07-02-89 |
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| | | US-A- 4893555 | 16-01-90 |
| GB-A-896973 | | NONE | |